RACIAL DIFFERENCES IN ADHERENCE TO CARDIAC MEDICATIONS

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Objective: To determine whether there are racial differences in adherence to cardiac medications.

Design: Retrospective analysis.

Patients: African-American and white male veterans aged 45 years or older who had received any of four groups of drugs: angiotensin-converting enzyme inhibitors (ACEIs), beta-blockers (BBs), calcium channel blockers (CCBs,) or HMG CoA (hydroxymethyl glutaryl coenzyme A) reductase inhibitors (statins).

Data: Administrative records were used to identify eligible veterans and their demographic characteristics, medical diagnoses, and medication use. We used a standard measure of adherence to medications based on whether the veteran obtained enough drug to take it as prescribed on 80% of the days.

Results: We identified 833 eligible African-American and 4436 eligible white veterans. In univariable analysis, African Americans were less likely to be adherent to medications than whites for ACEIs (81.4% versus 87.6%, $P = 0.004$), CCBs (75.3% versus 81.7%, $P = 0.003$), and statins (59.9% versus 74.1%, $P < 0.001$) but not BBs (84.8% versus 83.5%, $P = 0.6$). In multivariable analysis, racial differences in adherence to medications were found primarily among veterans younger than 55 years old.

Conclusions: Younger African Americans were less adherent to medications than whites in a setting where financial barriers are minimized. Although the reason for this finding is unclear, it may contribute to high cardiovascular morbidity among African Americans. (*J Natl Med Assoc.* 2003;95:17–22.)

Key words: adherence ♦ race ♦ hypertension hyperlipidemia ♦ calcium channel blockers

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Adherence to medications is an important predictor of positive clinical outcomes. Poor adherence to medications not only results in poor outcomes, but is associated with greater health care costs.[1] Indeed, inadequate adherence to medications has been cited as a major reason for poor control of hypertension.[2] Adherence to medications has been linked to socio-economic factors, such as race, age, marital status, and ability to pay.[3] Hypertension is reported to be both more common and more severe among African Americans than among their white counterparts.[4] Moreover, African Americans suffer disproportionately from

the sequelae of hypertension, including congestive heart failure,[5] end-stage renal disease,[6-8] and stroke.[9] Although the rates of acute ischemic heart disease are similar among African-American and white men, the rates among women are substantially higher in African Americans.[10,11] Not surprisingly, cardiovascular diseases overall are more common among African Americans than whites and cause a greater burden of mortality in the African-American community.[12] The reasons for these racial differences in the prevalence and control of hypertension are not clear. Theories include the impact of chronic stress related to direct and indirect effects of racism, cultural differences in diet, and differences in access to care.[13,14]

Although hypertension is a treatable disease, both African Americans and whites with hypertension frequently have less than optimal control of blood pressure, even when treated.[4,15,16] However, the racial disparity in outcomes suggests that optimal treatment may be especially important for African Americans. Indeed, African Americans appeared to derive greater benefit from intensive management of hypertension than did whites in the Hypertension Detection and Follow-up Program.[17] Similarly, in the equal access Department of Veterans Affairs (VA) health care system, African Americans and whites enrolled in hypertension clinics had similar rates of mortality.[18]

Likewise, treatment of dyslipidemia is associated with a substantial decrease in morbidity and mortality, especially in patients with established heart disease. Although African Americans have been underrepresented in clinical trials, they do not appear to benefit from treatment with lipid-lowering therapy such as the statins.[19]

The higher incidence of adverse cardiovascular outcomes in African Americans is explained in part by a higher prevalence of risk factors, such as hypertension and diabetes. Other factors, however, may be important, including differences in access to care,[20,21] differences in responsiveness to medications,[22] and, possibly, differences in adherence to prescribed medications.[23]

Adherence to medications is defined as the extent to which a person's behavior coincides with medical or health advice.[3] This definition can refer to such diverse behaviors as personal habits (alcohol or tobacco use or dietary changes), willingness to undergo medical procedures or attend scheduled visits, and the extent to which patients take medication as prescribed by physicians. Adherence to medications has been shown to be one of the most significant factors affecting clinical outcomes. Additionally, problems with adherence to medications make up a significant portion of many interactions between health care providers and patients. It has been estimated that only 50% of patients are adherent to long-term medication regimens.[3]

Not surprisingly, an extensive body of literature has examined factors associated with adherence to prescribed medications. They include both patient characteristics (e.g., age and gender) and the medical regimen (e.g., number of medications, frequency of dosing, and cost of medication). Lower rates of adherence to medications might contribute to the higher rate of complications from chronic diseases in the African-American community. If even a portion of the excess cardiovascular morbidity in African Americans relates to lower levels of adherence to medications, this area would be an important target for efforts to reduce racial disparities in health care.

Few studies directly compare adherence to medications among white and nonwhite patients. However, several authors have concluded that the adherence rate to medication is lower among African-American than white patients. For example, Ghali and colleagues found nonadherence to medications in 65% of patients, all of whom were African Americans, admitted with decompensated heart failure to a public hospital in Chicago.[24] Other studies have found racial differences in adherence to medications in specialized populations, such as those participating in randomized trials and those receiving Medicaid.[25,26]

Because inner-city populations are disproportionately African American, underinsured or uninsured, and lack access to appropriate medical care, there are many plausible explanations for a racial difference in adherence to medications.[27] Differences in health status persist after adjustment for access to care and socioeconomic status, so an important question is whether differences in

adherence to medications persist in populations without such barriers. Therefore, in the present study, we assessed adherence to medications among African Americans and whites using the Department of VA health care system, which provides eligible veterans with low or no-cost access to prescription drugs and primary care providers.

METHODS

We performed our study using computerized records maintained by the VA Pittsburgh Healthcare System (VAPHCS) in Pittsburgh, Pennsylvania. We used demographic records, records of all outpatient and inpatient visits, and computerized pharmacy records of all outpatient medications dispensed by the Pittsburgh pharmacy. African-American and white men who had at least three prescriptions filled between October 1, 1996, and March 31, 1998, for a drug from one of the four classes of cardiac medications (ACEIs, BBs, CCBs, and HMG CoA reductase inhibitors [statins]) were eligible for the study. The computerized administrative records of outpatient and inpatient visits from January 1, 1995, to December 31, 1997, were used to construct measures of existing comorbidity. Records of outpatient visits and pharmacy use from October 1, 1996, to March 31, 1998, were used to construct measures of disease burden and complexity of patients' medication regimens.

Subjects

We identified African American or white men, aged 45 years or older, who had at least 3 refills for one of the study drugs during an 18-month period. Because the relatively few women in this age group who use the VA may be atypical, we chose to exclude women from this study. To minimize problems with our measure of adherence to medications, we excluded subjects who were hospitalized during the study period. Thus, inpatient data on comorbidity were only available for patients hospitalized before, but not during, the study period.

A patient could contribute data for each of the four drug classes mentioned. Medication records were included if there were at least three refills with 10 or more pills of a study medication at one dosing schedule within the time frame. Medications for which the dosing schedule of the study drug changed during the course of the study were excluded because changes in dose affected the need for refills. When multiple drugs within a specific class met our eligibility criteria, we used information from all drugs prescribed. Thus, if a patient received three refills of a prescription for atenolol (a BB) and then later received three refills of a prescription for metoprolol (a second BB), we considered this to be two estimates of adherence to medications within the analysis of BBs.

Table 1. CALCULATING THE ADHERENCE RATIO FOR A HYPOTHETICAL PATIENT

Fill #	Fill date	Pills dispensed	Days supply	Cumulative days supply	Days elapsed between fills	Cumulative days elapsed
1	02/03/97	60	30‡	30	-‡	
2	03/26/97	60	30	60	48	48
3	06/04/97	60	30	90	71	119
4	08/04/97	60†	-†		61	180

Adherence ratio = Cumulative days of pills supplied/cumulative days elapsed = 90/180 = 0.5.
†These pills do not count toward the adherence ratio because only pills dispensed before the last refill date were included.
‡There are no days elapsed, because we began counting at the time of the first refill.

Table 2. BASELINE CHARACTERISTICS OF ELIGIBLE PATIENTS

	ACE		BB		CCB		Statins	
Characteristics	Blacks	Whites	Blacks	Whites	Blacks	Whites	Blacks	Whites
	392	1985	241	1418	409	1739	222	1778
Age in years (%)								
<55	†20.7	14.8	18.6	16.9	‡20.1	13.3	15.8	17.7
55-64	21.2	20.2	24.1	22.6	25.5	18.9	25.2	23.4
65-74	41.3	40.8	41.9	40.9	35.2	42.8	42.3	42.3
>74	16.8	24.3	15.8	19.5	19.3	25.0	16.7	16.7
Coexisting illnesses (%)								
IHD	10.7	12.3	20.8	22.0	11.9	13.2	24.3	21.2
Hypertension	‡24.5	15.1	‡31.5	16.3	‡27.2	15.6	‡23.4	12.8
CHF[†,]	5.9	4.6	4.6	2.9	3.7	3.3	3.6	3.0
Diabetes	‡29.3	8.9	†19.9	13.4	†20.3	15.2	‡28.4	15.9
Grouped Charlson (%)								
0	*72.5	78.3	†71.4	78.9	75.0	78.9	73.4	78.1
1-2	24.5	19.0	24.5	18.5	22.5	17.4	22.1	19.2
3-4	3.1	2.2	2.5	2.0	2.2	2.8	2.7	2.3
>4	0.0	0.5	1.7	0.6	0.3	0.9	1.8	0.5

ACEIs = angiotensin-converting enzyme inhibitors; BBs = beta-blockers; CCBs = calcium channel blockers; statins = HMG CoA reductase inhibitors; AAs = African Americans; IHD = ischemic heart disease; CHF = congestive heart failure; diabetes = diabetes mellitus with or without injected insulin

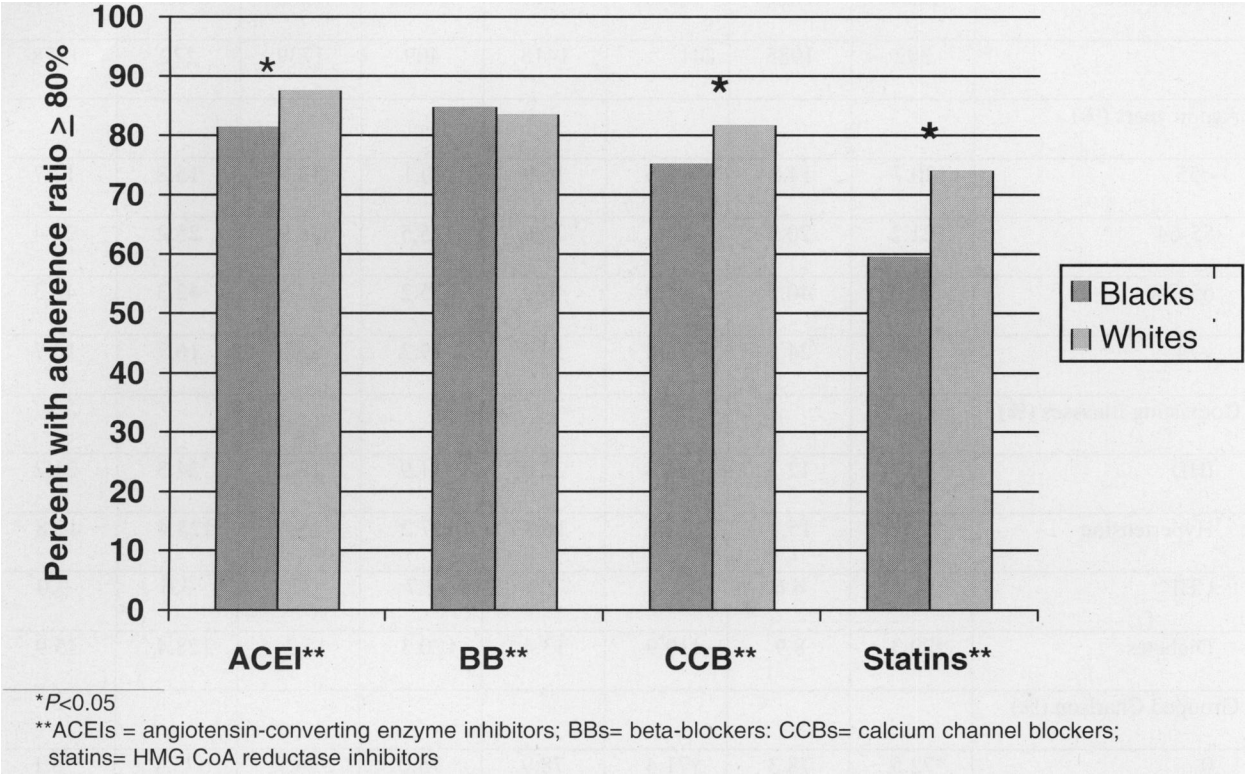
*P< 0.05, †P< 0.01, ‡P<.0001

Construction of a Measure of Adherence to Medications

We used the method of Steiner and colleagues to calculate a measure of adherence to medications called the "adherence ratio" (AR) for each eligible study medication for each patient.[28] To use this method, we first considered data on the dosing schedule and the number of pills dispensed to determine the number of days supply of pills with each refill. We added the number of days of pills available from all of these refills, except the last refill, to determine the days of pills available between the first and the last refill. Next, we calculated the number of days elapsed from the first refill to the last refill of the medication. Finally, we divided the days of pills available by the days elapsed to obtain the AR. An example of the calculation is provided in Table 1.

Medications with an AR > 1.5 or < 0.25 were excluded from the analysis, because these numbers were not considered to be related to adherence to medications. Rather, they reflected loss of bottles of pills, pharmacy errors, or misunderstandings between physicians and patients about whether to

Figure 1. RACIAL DIFFERENCES IN ADHERENCE TO MEDICATIONS BY DRUG CLASS



*$P<0.05$
**ACEIs = angiotensin-converting enzyme inhibitors; BBs= beta-blockers: CCBs= calcium channel blockers; statins= HMG CoA reductase inhibitors

start or stop a drug. Less than 1% of the study population was excluded for this reason.

Previous studies on adherence to cardiac medications suggest that patients are more likely to have the desired effect of treatment if they take 80% of the prescribed medication.[29] Moreover, a number of studies have used a rate of adherence to medications of 80% as a cutoff to classify patients as "adherent" or "nonadherent."[21,24] Therefore, in this study, a patient was defined as "adherent" if the calculated adherence ratio was greater than or equal to 0.80 and "nonadherent" otherwise.

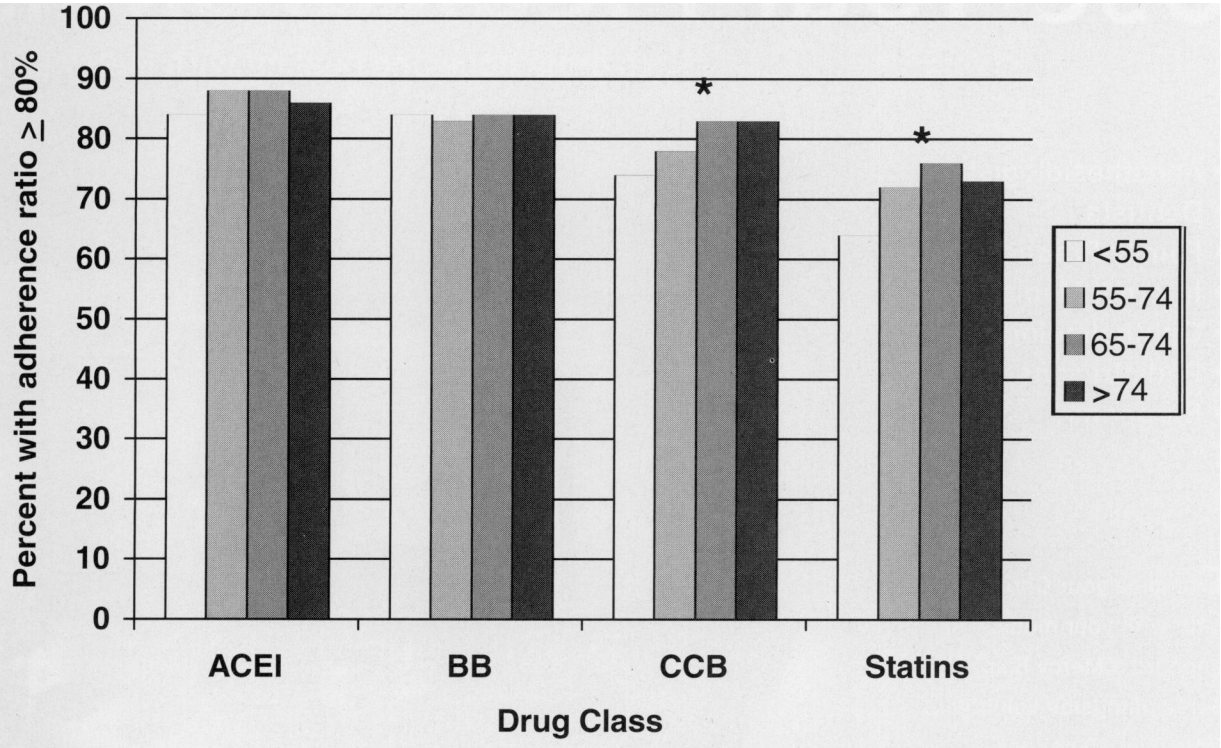
Construction of Independent Variables

Age. We categorized age as 45 to 54, 55 to 64, 65 to 74, and more than 74 years of age.

Comorbidity. We used ICD9-CM codes from outpatient and inpatient visits to identify specific conditions that might affect compliance with drugs in one or more of the classes, including hypertension, diabetes mellitus, chronic obstructive pulmonary disease, congestive heart failure, and coronary artery disease. The ICD9-CM codes were also used to compute the Deyo adaptation of the Charlson comorbidity index.[30,31] This index groups patients into four categories based on the presence of comorbidities. It has been shown to predict short- and long-term survival in a number of populations. As a second measure of disease burden, we counted the total number of outpatient medical visits during a 12-month period.

Complexity of the Medication Regimen. In the construction of the measure of the complexity of the medication regimen for each patient, we used the pharmacy database to identify all nonstudy oral medications filled in the study period. The number of different medications was used as an index of complexity of the medication regimen. Any prescription for injectable insulin was maintained as a separate variable. In addition, we tracked the number of times a day the study medication was to be taken and the number of pills (capsules) to be taken each time.

Figure 2. AGE DIFFERENCES IN ADHERENCE TO MEDICATIONS BY DRUG CLASS



**ACEIs = angiotensin-converting enzyme inhibitors; BBs= beta-blockers: CCBs= calcium channel blockers; statins= HMG CoA reductase inhibitors

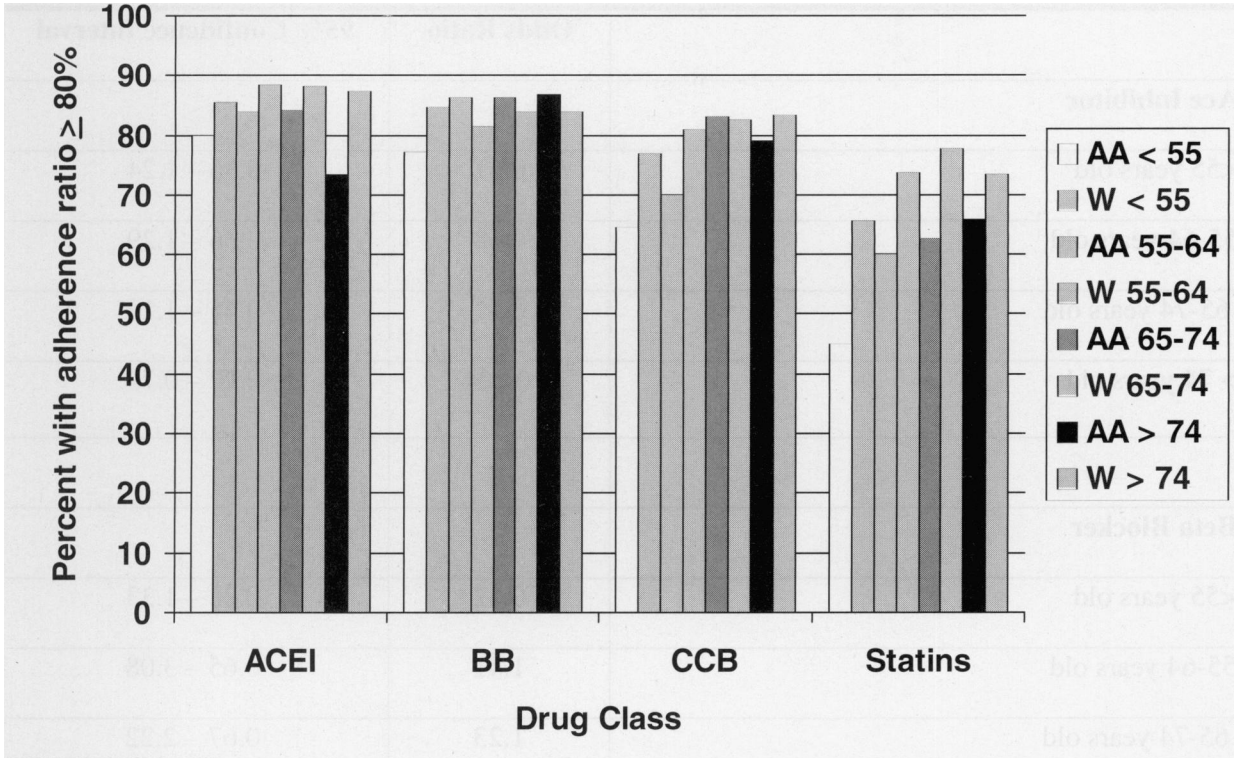
Analysis

Comparisons of African-American and white veterans were performed using *t*-tests or chi-squared tests as appropriate. Variables compared included demographic features, comorbidity, number of outpatient visits, and number of nonstudy oral medications. The relationship between race and adherence to medications was assessed using the AR both as a dichotomous (adherent or not) and a continuous measure. Initially, the univariable relationship between race and the AR was assessed with analysis of variance for the continuous AR measures and chi-squared statistics for the dichotomized AR measure. After initial analyses indicated that adherence to medications varied by drug class, we performed four parallel analyses of adherence to medications.

We used multivariable regression to test the association between race and adherence to medications while controlling for differences between races in potential confounders, including age, medical comorbidity, and complexity of the medication regimen. Because age was related to both race and adherence to medications, we included a race *x* age interaction.We used multivariable linear regression models for the continuous measure and logistic regression models for the dichotomized measure. For linear regression models, we used F statistics to identify significant associations. For logistic regression models, maximum likelihood statistics were used.

Analyses of the continuous and dichotomized measures of adherence to medications yielded equivalent results. For clarity, we present only the results of the dichotomized measure. Two sided p values of less than 0.05 were considered statistically significant. All analyses were performed using STATA 6.0. Subject was used as a clustering variable to account for possible multiple observations for the same subject.

Figure 3. RACE DIFFERENCES IN ADHERENCE TO MEDICTIONS BY AGE



**ACEIs = angiotensin-converting enzyme inhibitors; BBs= beta-blockers: CCBs= calcium channel blockers; statins= HMG CoA reductase inhibitors; AA = African-American; W = white

RESULTS

During the 18-month period under study, 833 African-American (with 1342 medication records) and 4436 white (with 7452 medication records) veterans were eligible for inclusion in the study. Split by drug class, 392 African-American and 1985 white veterans were included in the ACEI analyses, 241 African-American and 1418 white veterans were included in the BB analyses, 409 African-American and 1739 white veterans were included in the CCB analyses, and 222 African-American and 1778 white veterans were included in the statin analyses.

Demographic and disease characteristics for the veterans in the analyses are displayed in Table 2. Across all drug classes, African-American veterans were more likely to have hypertension and diabetes than were white veterans. In the groups taking ACEIs and BBs, white veterans had lower Charlson comorbidity scores than did African-American veterans. For veterans taking ACEIs and CCBs, African Americans were younger than whites.

Overall, veterans taking ACEIs were more likely to be adherent to medications (i.e., have ARs >80%) (86.6%) than veterans taking BBs (83.7%), CCBs (80.5), or statins (72.5%). As shown in Figure 1, African Americans and whites taking BBs were equally likely to be adherent (84.8 for black versus 83.5% for whites, P=0.6). African Americans were less likely than whites to be adherent to ACEIs (81.4% versus 87.6%, P=0.004), CCBs (75.3% versus 81.7%, P=0.003), and statins (59.9% versus 74.1%, P<0.001). As shown in Figure 2, the age group was significantly associated with adherence to CCBs and statins but not to BBs or ACEIs.

We next examined the relationship of race to adherence to medications within each age group. The percentages of veterans who were adherent to medications by race and age group are dis-

Table 3. ODDS RATIOS FOR ADHERENCE TO MEDICATIONS AMONG AFRICAN AMERICANS WITH AN ADHERENCE RATIO OF ≥80%, COMPARED TO WHITES FOR EACH AGE AND DRUG GROUP

	Odds Ratio	95% Confidence Interval
Ace Inhibitor		
<55 years old	0.67	0.36 – 1.24
55-64 years old	0.68	0.36 – 1.29
65-74 years old	0.71	0.45 – 1.12
> 74 years old	0.40†	0.22 – 0.73
Beta Blocker		
<55 years old	0.62	0.28 – 1.33
55-64 years old	1.41	0.65 – 3.08
65-74 years old	1.23	0.67 – 2.22
> 74 years old	1.27	0.49 – 3.31
Calcium Channel Blocker		
<55 years old	0.55*	0.32 – 0.94
55-64 years old	0.55*	0.34 – 0.91
65-74 years old	1.02	0.64 – 1.61
> 74 years old	0.76	0.42 – 1.35
Statins		
<55 years old	0.43†	0.22 – 0.82

ACEIs = angiotensin-converting enzyme inhibitors; BBs = beta-blockers; CCBs = calcium channel blockers.
*$P < 0.05$
†$P < 0.01$

played in Figure 3. The odds ratios for adherence to medications among African-American compared with white veterans for each age group are displayed in Table 3. Except for the oldest veterans in the analyses of ACEIs, the pattern that emerged from the race and age analyses is of racial differences only in the younger age groups. In the statin analyses, the racial difference between adherence to medications among African-American versus white veterans is similar in all age groups, although not statistically significant for those older than 74 years of age.

The relationship among race, age, and compliance was essentially unchanged in multivariate analyses controlling for comorbidity and complexity of the medication regimen.

DISCUSSION

Adherence to cardiac medications was lower in African Americans than whites in a health care system that provides low-cost access to both primary care and prescription medications. Our findings confirm previous reports of racial differences in adherence to medications and suggest that the difference is not solely the result of access problems. We also found consistent evidence that these differences were most prominent among younger African Americans, a finding that has been reported by others. Unexpectedly, we found that these disparities were more prominent when patients were taking CCBs (indicated for hypertension or angina) or HMG CoA reductase inhibitors (cholesterol-lowering agents). As with other studies in older populations, compliance did not decrease with age.[32]

This study is believed to be the first to demonstrate this drug class-specific effect. We note that CCBs are often considered a first choice for antihypertensive drug therapy in African Americans, so it is possible that they may be more likely to receive them for that indication, rather than for angina. If the presence of symptomatic angina is associated with improved compliance, and whites are more likely to have angina than African Americans, perhaps that would explain the finding. However, our analysis of comorbid conditions did not find any evidence to support this theory; patients with and without hypertension and ischemic heart disease were equally likely to be adherent to medications.

Alternatively, because CCBs have been found to have a greater effect on lowering blood pressure in African Americans than in whites,[33] it may be that African Americans also experience more side effects, such as fluid retention or impotence. This finding has not been reported in previous studies of these agents, and we emphasize that our data do not address the reason(s) for this difference. Differences in side effects should be the subject of future research. The reason for the difference in statin therapy is similarly elusive.

Our finding of an interaction between race and age is also somewhat novel. Although previous studies have found that adherence to medications varies among age groups, it has not been suggested that this phenomenon is more prominent among African Americans. In one recent Medicaid claims-based study of adherence to hypertensive medications, both African-American race and younger age were associated with better adherence to medications, but the terms of interaction were apparently not examined.[26] Similarly, in a study of adherence to sulfonylurea therapy among patients with diabetes who were not taking insulin, adherence to therapy was inversely associated with African-American race and younger age.[34] Once again, interactions were not examined.

Possible reasons for the lower rates of adherence to medications sometimes observed among African Americans included access to care, economic barriers, and beliefs about medications. By using patients treated in a single VA medical center, we minimized the effect of differences in access to care and cost of medications. However, our study did not gather data about side effects, patients' beliefs, or the physician/patient relationship. Moreover, although we used a standardized measure to control for differences in medical comorbidity, this measure did not include such potentially important factors as mental illness or substance abuse. In one previous study, race was a predictor of adherence in a univariable analysis but became insignificant in a multivariable model that included a history of drug abuse, a perceived cause of hypertension, and a pattern of medication use. Future studies based on theoretical constructs such as the health belief model might be

helpful to determine the factors associated with reduced adherence to medications among younger African Americans.

Our study has several limitations. Most important, it is a review of pharmacy records, relying on prescription refills to measure the rate of adherence to medications. This approach is only an indirect measure of adherence to medications. It is possible that the refilled medications were not being used as prescribed. However, this approach is a well-validated measure. Other measures of adherence to medications, such as pill counts, patients' self-reports, and electronic monitoring systems, also have limitations.

In addition, we relied on ICD9-CM codes to identify comorbid diagnoses. These codes are known to have problems with documentation. Despite the limitations of measures of comorbidity based on the codes, the fact that this study was able to link pharmacy records to diagnostic and utilization data to control for differences in comorbidity is a significant advance over many previous studies.

Similarly, race is imperfectly recorded in administrative datasets,[35] presumably including that maintained by the VA. Such misclassification would tend to bias our estimates of racial differences in adherence to medications to a finding of no difference.

We were not able to reliably control for indication for the prescribed medication. It is possible that patients were more likely to be adherent to a medication when the drug was given for heart disease rather than for hypertension; if these indications are differently distributed among African Americans and whites, we may mistakenly attribute a difference to race when it is the result of indication.

Furthermore, we tried to adjust for cost of medication and access to care. The required co-payment for each drug ($2/month supply) might be a burden for some patients. We do not have data on income by race so cannot comment on the potential importance of this finding, but we do note that the co-payment does not apply to very low-income veterans. Similarly, patients residing in rural areas may have found it more difficult to make their medical appointments. However, in this particular setting, whites are actually more likely than African Americans to live a significant distance from the medical center.

Because not all eligible veterans use VA care, it is possible that the racial difference we observed is the result of differences in the reasons for seeking care. Thus, it might be that whites are more likely than African Americans to seek VA care solely to obtain medications, which might be associated with a higher rate of adherence to medications. However, at the time of the study, the study hospital strongly discouraged patients from using the VA solely for this purpose, so this conclusion seems unlikely.

Finally, it is worth noting that this is a single-site study, and our results may not apply to other populations. In particular, the fact that the study was performed through the VA limits its generalizability to women and to populations for whom drug costs are more important and socioeconomic status is more diverse.

CONCLUSION

In a setting where economic barriers are minimal, the rate of adherence to medications in African Americans was significantly lower than that in whites overall, but this finding was more pronounced for certain drug classes (CCBs and statins) and in the youngest age groups (45 to 54 and 55 to 64 years of age) in our relatively old study population. Our results suggest that economic barriers are not the sole cause of differences in adherence to medications. Future studies including detailed clinical information and a more diverse population in terms of age and gender are needed to fully understand our results. It is crucial for researchers to recognize that adherence to medications is not solely a problem for patients, but rather reflects a problem for patients, providers, and systems.

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REFERENCES

1. Rizzo JA, Simons WR. Variations in compliance among hypertensive patients by drug class: implications for health care costs. *Clin Ther.* 1997;19:1446-1457.

2. Joint National Committee on Prevention DEaToHBP. The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Arch Intern Med.* 1997;157:2413-2446.

3. Eraker SA, Kirscht JP, Becker MH. Understanding and improving patient compliance. *Ann Intern Med.* 1984;100:258-268.

4. Burt VL, Whelton P, Roccella EJ, et al. Prevalence of hypertension in the US adult population. results from the Third National Health and Nutrition Examination Survey, 1988-1991. *Hypertension.* 1995;25:Abstract.

5. Alexander M, Grumbach K, Selby J, Brown AF, Washington E. Hospitalization for congestive heart failure: explaining racial differences. *JAMA.* 1995;274:1037-1042.

6. Rostand SG, Kirk KA, Rutsky EA, Pate BA. Racial differences in the incidence of treatment for end-stage renal disease. *N Engl J Med.* 1982;306:1276-1279.

7. Rostand SG, Brown G, Kirk KA, Rutsky EA, Dustan HP. Renal insufficiency in treated essential hypertension. *N Engl J Med.* 1989;320:684-688.

8. Whittle JC, Whelton PK, Seidler AJ, Klag MJ. Does racial variation in risk factors explain black-white differences in the incidence of hypertensive end stage renal disease. *Arch Intern Med.* 1991;151:1359-1364.

9. Feldman RH, Fulwood R. The three leading causes of death in African Americans: barriers to reducing excess disparity and to improving health behaviors. *J Health Care Poor Underserved.* 1999;10:45-71.

10. Gillum RF. Trends in acute myocardial infarction and coronary heart disease death in the United States. *J Am Coll Cardiol.* 1994;23:1273-1277.

11. Rosamond WD, Chambless LE, Folsom AR, et al. Trends in the incidence of myocardial infarction and in mortality due to coronary heart disease, 1987 to 1994. *N Engl J Med.* 1998;339:861-867.

12. Francis CK. Hypertension and cardiac disease in minorities. *Am J Med.* 1990;88(3B):3S-8S.

13. Boutain DM, Cooke C. The association between racism and high blood pressure among African Americans. *Ethn Dis.* 2001;11:793-799.

14. Williams DR, Neighbors H. Racism, discrimination and hypertension: evidence and needed research. *Ethn Dis.* 2001;11:800-816.

15. Berlowitz DR, Ash AS, Hickey EC, et al. Inadequate management of blood pressure in a hypertensive population. *N Engl J Med.* 1998;339:1957-1963.

16. Pavlik VN, Hyman DJ, Vallbona C. Hypertension control in multi-ethnic primary care clinics. *J Hum Hypertens.* 1996;10(Suppl 3):S19-S23.

17. Hypertension Detection and Follow-up Program Cooperative Group. Five-year findings of the Hypertension Detection and Follow-up Program: II. mortality by race-sex and age. *JAMA.* 1979;242:2572-2577.

18. Miller JP, Perry HM Jr, Rossiter JE, Baty JD, Carmody SE, Sambhi MP. Regional differences in mortality during 15-year follow-up of 11,936 hypertensive veterans. *Hypertension.* 1994;23:431-438.

19. Lipid Research Clinics Program. The Lipid Research Clinics Primary Prevention Trial results: reduction in incidence of coronary heart disease. *JAMA.* 1984;251:351-364.

20. Blendon RJ, Aiken LH, Freeman HE, Corey CR. Access to medical care for black and white Americans: a matter of continuing concern. *JAMA.* 1989;261:278-281.

21. Washington DL, Harada ND, Villa VM, et al. Racial variations in development of Veterans Affairs ambulatory care use and unmet health care needs. *Mil Med.* 2002;167:235-241.

22. Jamerson K, DeQuattro V. The impact of ethnicity on response to antihypertensive therapy. *Am J Med.* 1997;101:3A-22S-3A-32S.

23. Daniels DE, Rene AA, Daniels VR. Race: an explanation of patient compliance—fact or fiction? *J Natl Med Assoc.* 1994;86:20-25.

24. Ghali JK, Kadakia S, Cooper R, Ferlinz J. Precipitating factors leading to decompensation of heart failure. *Arch Intern Med.* 1988;148:2013-2016.

25. Black DM, Brand RJ, Greenlick M, Hughes G, Smith J. Compliance to treatment for hypertension in elderly patients: the SHEP pilot study. Systolic Hypertension in the Elderly Program. *J Gerontol.* 1987;42:552-557.

26. Monane M, Bohn RL, Gurwitz JH, Glynn RJ, Levin R, Avorn J. Compliance with antihypertensive therapy among elderly medicaid enrollees: the roles of age, gender, and race. *Am J Public Health.* 1996;86:1805-1808.

27. Shea S, Misra D, Ehrlich MH, Field L, Francis CK. Predisposing factors for severe, uncontrolled hypertension in an inner-city minority population. *N Engl J Med.* 1992;327:776-781.

28. Steiner JF, Koepsell TD, Fihn SD, Inui TS. A general method of compliance assessment using centralized pharmacy records: description and validation. *Med Care.* 1988;26:814-823.

29. Haynes RB, Taylor DW, Sackett DL. Compliance in Health Care, 1st ed. Baltimore: Johns Hopkins University Press; 1979.

30. Charlson ME, Pompei P, Ales KL, Mackenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis.* 1987;40:373-383.

31. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol.* 1992;45:613-619.

32. Darnell JC, Murray MD, Martz BL, Weinberger M. Medication use by ambulatory elderly an in-home survey. *J Am Geriatr Soc.* 1986;34:1-4.

33. Materson BJ, Reda DJ, Cushman WC, et al. Single-drug therapy for hypertension in men: a comparison of six antihypertensive agents with placebo. The Department of Veterans Affairs Cooperative Study Group on Antihypertensive Agents. *N Engl J Med.* 1993;328:914-921.

34. Sclar DA, Robison LM, Skaer TL, Dickson WM, Kozma CM, Reader CE. Sulfonylurea pharmacotherapy regimen adherence in a Medicaid population: influence of age, gender and race. *Diabetes Educator.* 1999;25:531-538.

35. Blustein J. The reliability of racial classifications in hospital discharge abstract data. *Am J Public Health.* 1994;84:1018-1021.